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SEED-BORNE PARASITES—A GENERAL CONSIDERATION OF THE PROBLEM[1]

INTRODUCTION

AGRICULTURE is the basic industry of the world. The problems relating to the improvement of this industry are therefore of vital interest universally, even though this fact may not be recognized generally by the mass of humanity.

While agriculture has progressed steadily during the past few decades it has not kept pace with the progress of certain other industries which *may appear* to be more generally dependent upon the progress of the fundamental sciences. One reason for this seems to lie with the farmers, who have not generally reached the point where they realize the need and the possibilities of improving their industry through the adoption of better practices based upon sound scientific principles. An example of such an attitude on the part of the farmer may be taken from one of the best established disease control principles. It has been known for years that the spraying of fruits is one of the most profitable practices for the orchardist, but in spite of this it is doubtful if more than a relatively small percentage of the fruit trees on this or any other continent are systematically sprayed. The spraying of potatoes was known before 1900 to be very profitable in the regions where the late blight or rot prevails, but even to-day there are many thousands of acres of potatoes which are unsprayed annually in these same areas. More recently we have been able to show that spraying potatoes, with the proper materials, at the proper time, and in the proper manner, is extremely profitable in most large potato-growing sections of the United States, but still the great majority of potato-growers hang back and fail to take advantage of this knowledge. The chief remedy for this situation of course lies in more effective extension work, although we must admit that further investigation is needed to clear up some of the more obscure phases of the spraying problem.

The examples above are cited for the purpose of showing how slowly the agricultural industry takes

[1] Invitation address delivered before the Canadian Branch, American Phytopathological Society, Kingston, Ontario, December 20, 1923. Contribution from the Department of Botany, The Pennsylvania State College, No. 45.

advantage of practices, the profitableness of which are well known. If one can generalize from such conditions it is quite clear that we have far to go before any very general program of plant protection can be put into practice. This condition, however, must not discourage the workers in this field. They have their field of endeavor lying ahead and the conquerors of this field are yet to be crowned.

Of the numerous phases of plant protection which are of major importance, that of the dissemination of parasites has received little consideration, except from the academic standpoint. It is my hope, therefore, that the presentation of a special phase of parasite dissemination, *viz.*, by means of the seed, may at this time serve to emphasize the necessity of further consideration of these matters and prove an incentive to basic research along these lines.

Importance of Plant Diseases in Agriculture

The phytopathologists and economic entomologists are well aware of the extreme importance of plant parasites to the agricultural industry, but there are many other scientists and millions of farmers who have no adequate concept of the magnitude of the losses occasioned by such parasites. The phytopathologists of the United States have taken the lead in compiling statistics on crop losses caused by parasitic bacteria and fungi. Canada and England have followed this lead and are now publishing annual estimates of such losses. The entomologists in the United States have quite recently initiated a similar service, and it appears that within the next decade we shall have some fairly accurate statistics on crop losses for North America and Europe. For the United States the following statistics have appeared in "The plant disease bulletin" of the U. S. Department of Agriculture.

Crop	1918	1919	1920	1921	Averages
Wheat	33,171[2]	192,275	104,129	80,592	102,542
Barley	16,533	10,445	9,747	9,249	11,987
Oats	63,396	78,353	78,199	99,159	79,777
Corn	158,533	200,050	220,862	297,561	219,251
Potato	78,094	86,997	119,474	79,518	91,021
Sweet Potato	47,136	58,841	39,150	38,879	46,001
Tomato	841,763	307,168	.....	.....	.....
Cotton	2,160	1,742	2,002	1,568	1,868
Apple	19,273	18,920	47,474	12,380	24,512
Peach	3,664	7,026	10,505	5,918	6,778

These figures represent only a small part of the total losses to our cultivated crops in the United States from disease. We may assume that the situation with respect to vegetable, forage, ornamental and forest crops is about the same. In the field of economic entomology it has been estimated that the annual loss from destructive insect pests in the United States is not less than two billion dollars. In some cases the control of the diseases of a single crop alone, such as potatoes, is of sufficient importance to transform farming from an unprofitable into a profitable industry, and if we were able to add the control of the insect pests and diseases affecting all other farm crops this industry would become much more profitable that it is at the present time. Stating it another way, the crop diseases of plant, insect and animal nature bid fair to become the chief limiting factors in crop production—in fact, they can be shown to be such already in the case of the potato crop, and what is true of this crop is probably true of other crops.

It would be interesting to know to what extent the losses to farm crops from disease are attributable to seed-borne parasites. We can gain some notion of this by scanning the detailed estimates in "The plant disease bulletin," from which the figures quoted above were taken. Averaging the losses for the four years over which the data have been collated it appears that seed-borne bacterial and fungous parasites have been responsible for reducing the wheat crop of the United States 2.3 per cent., the barley crop 3.1 per cent., the oat crop 3.2 per cent. and the bean crop 6.1 per cent. annually. It is apparent that seed contamination by parasites plays an important rôle in reducing the production of many of our most important food crops. Statistics on textile, forage and vegetable crops (other than beans) are not at present available. If we admitted to the argument the vegetative parts of plants commonly used in reproduction, such as the potato tuber, etc., the figures would be startling.

History of Seed-borne Parasites

While references to the transmission of plant diseases by the seed can be traced as far back as 1730, in the writings of Jethro Tull, it appears that Gleichen, in 1781, was the first to demonstrate that bunt of wheat is carried on the seed, and Tessier, in 1789, was the first to show that the treatment of the seed with copper sulphate was effective in controlling this disease. It was not, however, until about the middle of the 19th century and later, through the researches of the Tulasnes, deBary, Kuehn, Fischer, Von Waldheim, Wolff and Brefeld, on the smuts that the phenomena of seed infestation and infection were fully demonstrated. Frank, in 1883, proved that bean anthracnose was seed-borne by means of the mycelium which grows through the pod into the seed during its early maturing period. Since this date

[2] All figures in bushels except for cotton, which are in bales; 000 omitted in all cases.

many fungous and bacterial diseases of plants have been shown to be seed-borne until at the present time the number which the joint committee of the American Phytopathological Society and the Crop Protection Institute has recorded exceeds 160, with much of the foreign literature still to be reviewed.

PLANT DISEASES INTRODUCED TO AMERICA FROM FOREIGN COUNTRIES

Without doubt most of the more serious diseases of cultivated crops in North America and some of those affecting forest trees have been introduced from foreign countries within comparatively recent years. Asparagus rust; the smuts, rusts, downy mildew, stripe diseases, and ergot of cereals; club root and black-leg of cabbage; several of our most serious potato diseases, such as late blight, leaf roll, powdery scab, wart, and others; chestnut blight; poplar canker; white pine blister rust; grape anthracnose; citrus canker; nectria canker and scab of apple; brown rot, leaf curl, and scab of peach; bean anthracnose; early and late blight of celery; anthracnose and downy mildew of cucumber; downy mildew of onion; pea blight; carnation and chrysanthemum rusts; stem nematode, rust, and crown wart of alfalfa; probably the root knot nematode and many others have been introduced from foreign lands.

I would not wish my hearers to gather the impression that other countries have not been inflicted with plant parasites introduced from North America. European literature is well filled with the facts pertaining to such diseases as grape black rot and downy mildew, gooseberry powdery mildew, stripe of tomatoes, and others, but there has been no such general exportation of host plants from the United States, and consequently there has been no such wholesale invasion of their borders by parasites from North America as has taken place in the other direction. The child has "inherited" the ills of its parents.

SPREAD OF PLANT PARASITES IN NORTH AMERICA

The interstate migration of plant diseases in the United States has been presented graphically by Stevens for asparagus rust, fire blight and peach yellows. That many of these diseases have been more or less rapidly widening their distribution within our borders is evident. The apple blotch disease first studied in the lower Mississippi Valley has traveled eastward and northward until it is pretty generally distributed east of the Mississippi River except in the New England states. Its spread westward has not been so marked. Many other examples might be cited, but two or three diseases spread by seed might be mentioned. I have already described elsewhere the spread of an important tomato disease variously known as "winter blight," "stripe" or "streak." This disease was first reported in the greenhouses at Cornell University in 1892. It was reported in Ohio in 1897, Pennsylvania 1907, Indiana 1916, Ontario 1916, California 1919, etc. It has also spread to Australia, New South Wales and Great Britain in recent years. This disease has been shown, by studies conducted in my laboratory, to be seed-borne and it will undoubtedly spread to many other regions within the next few years. The black leg of cabbage, another seed-borne disease, which came to America presumably from Europe, was first reported in Ohio in 1909. Since that date it has been reported widely in the United States and during certain years is a very destructive disease. Bean anthracnose, another destructive disease caused by a seed-borne fungus, was apparently first recorded in the United States from Cambridge, Massachusetts, where it has been known since 1882. Since then, according to Barrus, this disease has been reported from every state in the Union except South Dakota, Wyoming and Nevada and doubtless it occurs also in these states.

From these few examples, which might be multiplied almost indefinitely, it is seen that seed-borne parasites have played a very important rôle in the dissemination of plant diseases, and that unless this condition is recognized more generally and preventive measures taken it will be but a few years before such diseases are distributed wherever their hosts are grown and environmental conditions permit their development.

IMPORTANCE OF PATHOGEN FREE SEED IN CROP PRODUCTION

There are, of course, many factors entering into successful crop production, but from the standpoints of yield and quality, the health of the seed must be admitted to be a factor of first importance. When all the other factors, such as nutritive relations, moisture and temperature, are favorable for successful production the crop may be a failure because of parasites which are seed-borne. Bean anthracnose and bacterial blight are excellent examples of the many almost exclusively seed-borne diseases which destroy our crops annually. If bean seed is planted when infected with either of the parasites causing these diseases, the results are almost invariably disastrous. At the present time we have no satisfactory way of checking these two bean diseases once they have appeared on the growing host. Disease free seed is the one satisfactory method of dealing with these problems, except by the use of resistant varieties which are now being developed.

The problem does not stop with those diseases which are more exclusively seed-borne. In the cases of tomato and cotton wilt, caused by two specific fungous parasites usually considered as soil-inhabit-

ing organisms, it has recently been shown by Edgerton and Elliott that contaminated seed may serve to initiate these diseases in the field. The problem has no end or at least there is no end in sight.

NATURE OF SEED-BORNE PARASITES AND THEIR METHOD OF DISSEMINATION

It is well known that animal and insect life may be seed disseminated, but I shall discuss under this phase of the paper only those parasites which are of a plant nature. These parasites are either bacterial or fungous in nature but of varied form and development. So far as known the bacterial plant parasites are all of the usual simple cell types which do not form "spores." The fungous parasites are much more varied in their form. Polysporous forms are common and other complexities exist. In general, the fungi are seed disseminated by means of spores or spore receptacles adhering to the surface of the seed integuments (*external transmission*), or they may be carried within the seed or integuments (*internal transmission*), in the form of their vegetative or resting mycelium. Certain fungi also may be carried with the seed in the form of sclerotia, stromata and other resting stages such as occur with ergot, *Sclerotium* spp., etc. All these methods of dissemination upon, with and within the seed may be utilized by fungous parasites with great effectiveness. In some cases the method whereby the parasite is carried is well known; in other cases it has not been fully worked out. Among the most highly developed and effective methods of seed transmission are those loose smuts of wheat and barley in which infection takes place through the floral parts, the mycelium entering the growing point of the embryo, where it remains dormant until the embryo resumes growth at the time of germination. The mycelium then develops along with the growing point but only produces spores in the spike at the time the latter approaches maturity within the sheath. The spores are again disseminated as soon as the infected spikes emerge from the sheath and at the time the normal healthy spikes are in bloom. Freeman has described what is perhaps a still more highly specialized type of seed parasitism in the case of the "seed fungus" of *Lolium tementulum*. This fungus is said to produce no spores and to overwinter by means of its mycelium outside the aleurone layer, in the scutellum and in the growing point of the plumule. By such methods the parasite insures its perpetuation from year to year without the risk attendant to the methods utilized by many parasites which are disseminated by spores adhering to the surface of the seed or fruit. In these latter cases the safety of the parasite may appear to lie with the enormous number of spores produced.

Among such a varied group as the fungi, comprising as they do several orders with innumerable intergradations of nutritive relations from obligative saprophytism to obligative parasitism, it might be expected that some instances would occur of a relation between the stage of parasitism attained and the methods of seed dissemination. Possibly such relations will eventually be shown through a more thorough investigation of the life histories of such a group as the smuts. The instances of mycoplasmic transmission described by Eriksson for the rusts have not yet been generally accepted, but further researches in this field are highly desirable. If we accept the symplastic condition for the bacteria, as described by Lohnis and Smith and others, there is less ground for doubting that such a condition may be proven eventually for the fungi.

RÔLE OF COMMERCE IN THE DISSEMINATION OF PARASITES

The period of very active dissemination of plant parasites was ushered in with the development of our vast interstate and transcontinental systems of transportation. This period began about 1885 and may be said to be concluded only within the past decade. During that period a majority of our plant parasites were introduced and widely disseminated, though of course the dissemination is still continuing and possibly with even greater frequency. Other factors, such as the mail, parcel post and congressional distribution of seed have undoubtedly furthered such disease dissemination. The only real brake which assisted in checking this widespread distribution of plant diseases in the United States was the passage of the Simmons bill, which became the Plant Quarantine Act, August 20, 1912. Since that date there appears to have been a slowing down of the rapid distribution of plant parasites, especially among those species which are generally carried on propagative stocks, plants with roots and soil, etc. The forms which are more specifically seed-borne have not been checked so effectively by this quarantine which did not, during its early inception, take into close consideration these particular forms. However, since 1919, with the passage of the nursery stock, plant and seed quarantine No. 37, the question of seed transmission has been given more careful consideration.

PARASITES NOT YET INTRODUCED TO NORTH AMERICA

While we have already more plant parasites than we can hope to combat successfully in the next half century, there are many more in other countries which are only awaiting a favorable opportunity for emigration. Of such we know comparatively little except from the published lists and, for the most

part, brief accounts in the literature of foreign countries. We do have, however, sufficient experience with those diseases which have already found their way to our domain, to warn us of the grave danger of each and every one of these potentially serious foreign plant diseases. This experience has almost invariably taught that newly imported parasites are more destructive than any parasites native to this continent, and that furthermore once they are introduced to our shores they become permanent boarders. We have yet to prove that a single disease once established can be completely eradicated. We can not be over careful in dealing with such enemies. As Spaulding has stated, "we are in constant and increasing danger from serious foreign plant diseases, and this danger is much greater than the public believes can be possible." The United States and Canada could well afford to spend large sums gaining more complete knowledge regarding these as yet unintroduced parasites, many of which undoubtedly are capable of being transmitted with seed.

Regions in North America where Plant Parasites have not yet become established

While it is evident that many of those plant diseases which have been in our midst for a comparatively long time are already widely distributed, there are still many of the more recent acquisitions which have not as yet become generally distributed within our borders. Two examples of parasites attacking alfalfa may be cited as illustrating this point; the crownwart disease caused by *Urophlyctis alfalfae,* and the stem nematode caused by *Tylenchus Dipsaci.* Both of these parasites have been introduced from foreign countries, quite probably on alfalfa seed. At the present time their distribution is more or less local in the western United States, but they are spreading and this past year *Tylenchus Dipsaci* was recorded in New Jersey. We shall have to move quickly to head off these parasites from further invasion of new territory. The movement of alfalfa seed from infested areas should not be permitted. There are many other examples of the same sort, such as the Physoderma disease of maize introduced into the southern United States, and it would appear probable that a number of such diseases could be restricted from further spread if strict measures were taken promptly. A good example of what may be accomplished in this direction is afforded by the apparently successful attempts in preventing the further spread of the potato wart disease in the United States and Canada. Thorough surveys should be made at once, particularly with respect to these more recently discovered diseases and pests. Only by such data at hand can we intelligently direct efforts against the further distribution of such parasites.

Methods of attacking the Problem of Seed-borne Parasites

Much of what I have already stated applies to plant diseases in general. I shall now try to confine further remarks to the problem of seed-borne parasites. However, it would appear that the problem, so far as the seed is concerned, is only a part of the more general one of disease prevention and as such can not be restricted too closely since the fundamentals remain the same.

In the first place, some organization is necessary. We can not hope to accomplish what needs to be done single handed or by unguided efforts. We need the keenest minds and the most persistent workers on this problem, which is an exceedingly complex one. It is complex because of its varied aspects and because so little has been done to guide us in the best methods of technique. It involves as possibly no other closely related problem, a detailed study not only of the life history of the parasite but also that of its host from seed to seed. Coupled with these studies should be those which will inform us accurately as to just how any specific parasite on or within the seed is transmitted to the seedling or to the growing plant. Very few tracings of this sort have been made. It is complex because it involves on the one hand a specialized industry in seed production and on the other hand a generalized and unorganized industry of crop production—the agriculture of our country. These two agencies, between which the investigator must take his stand, must be brought to see the importance of this problem, and induced to bring support for its solution. I believe this can be done, but only by the concerted efforts of a considerable number of persons who will use their influence to bring the matter to an issue. There can be no doubt of its importance. The problem strikes deep at the fundamentals of disease control. The problem is complex further because it is international as well as interstate in scope. These parasites recognize no boundaries except those which we can artificially erect with more or less success and for this reason alone the problem involves many legal principles which are intricate. There are other complications attached, but I do not wish to discourage any one from attacking this problem by enumerating further these difficulties which beset the way. I only wish to point out the most obvious difficulties with the hope that once seen the more easily may they be avoided.

The Research Phases of the Problem

One of the reasons why we have not progressed further in the investigations on seed-borne parasites is because we have been relying too much upon empirical methods. After we have demonstrated that

a specific parasite is seed-borne we are prone to turn at once to the various methods of treatment with the hope that a short cut can be found to the solution of the seed-borne phases of the problem. Sometimes this works out and doubtless much time is saved in such cases, but we have any number of other cases where much time has been wasted in empirical tests. In all these cases we need research methods applied to the solution of these problems. As stated above, we need to know just how each of these specific seed-borne organisms infect or infest the seed as well as their further development to infect the seedling or the growing host. With this information fully worked out, it should simplify greatly the methods of treatment to be employed in each specific case. There are many other research phases of these problems, some of which will be discussed in the following paragraphs.

CUMULATIVE EFFECTS OF PARASITES

Nature is considered to be the great adjustress of biological phenomena. Natural agencies bring about adjustments and adaptations of living organisms to their environment. This is accomplished in a more or less uniform way so long as nature is not interfered with by artificial methods created by man. It is perhaps by creating such artificial conditions that many of our epiphytotics are brought about. Systems of cultivation, fertilization, rotation and other general practices undoubtedly affect both the parasite and the host and not infrequently create conditions especially favorable to the parasite. If such conditions are created over two or three successive seasons epiphytotics are almost certain to result. Here again lies a fertile field for cultivation by the investigator. The work of L. R. Jones and his associates on the effects of soil temperatures upon parasitism has paved the way for an extension of these lines of research. We very much need accurate information on the effects of temperature, moisture and other factors upon the development of parasites which are seed-borne. Presumably, these environmental factors are of major importance in determining the success or failure of any specific seed-borne organism to infect its growing host plant.

Comes has discussed the influence of climate upon the susceptibility of plants to disease and believes in general that the introduction of parasites into warmer and more humid climates is apt to increase their destructiveness. He also believes that nitrogenous manures, in general, tend to reduce the resistance of the host. I am convinced that one of the most important reasons for rotation of crops is because of the tendency of this practice to retard the accumulation of specific parasites.

W. A. Orton has summed up the general conditions with respect to newly introduced parasites as follows: "Parasitic fungi thus transferred to a new environment have found species of plants closely related to their original host, but lacking the resistance or endurance possessed by that host. The newly introduced parasite spreads under such conditions with a rapidity and destructiveness never observed in its original habitat." This of course applies with equal force to both inter and intra-continental introductions.

Another related phase of this problem which appears to be deserving of attention, but upon which we have very little exact information, is that of readjustment of crop distribution. While it is probably true that our present crop distribution is in general based upon adaptation to environments, there is still to be considered the possibility of reducing the losses from parasites by centralization of certain crops and particularly so in the production of seed and other reproductive parts. As instances indicating such possibilities, that of black-leg of cabbage, a destructive fungous disease, may be cited. It has been shown that this disease fails to develop, for some unknown reason, in the cabbage-growing regions of Puget Sound, Washington. We may find it advantageous to develop there a cabbage seed producing industry. Likewise, five years' experience in Pennsylvania with seed potatoes from many sources has shown conclusively, for some unaccountable reason, that seed tubers grown in certain areas in Michigan are more free from disease than from any other known source. Other instances of a similar nature are known, but so far little advantage has been taken of these pointers which are much in need of further study.

METHODS OF TESTING SEED FOR THE DETECTION OF PARASITES

At the present time there are no standards nor reliable methods known for detecting the presence of parasites on or within seed unless it be in the case of corn. More than twenty years ago Bolley pointed out a method of centrifuging various sorts of seed for the purpose of detecting and identifying the spores of fungi carried upon the seed. This method has been utilized in other laboratories with considerable success, but unfortunately it is only a help and not a solution of the problem. In the case of internal parasites surface disinfection has been very helpful, but the methods of developing and culturing the internal parasities are extremely faulty and much study is needed on this point. Here, again, the factors of temperatures and moisture add to the complexities of the problem. In some cases the presence of such parasites have only been detected upon the germination of the seed and the development of the plant, and we are often thwarted at the beginning

through our failure to induce the seed to germinate. We are also frequently baffled by our failure to induce growth of the parasite from spores, sclerotia and mycelium.

SEED PRODUCTION METHODS

The fact is that seed production is so largely in the hands of the seed trade that plant pathologists have not especially concerned themselves with the methods employed. No doubt a great deal of very valuable information might be gained through a careful survey and analysis of seed production methods. The factors of protection, sanitation, harvesting, curing, storing and general handling of the crop and the seed need detailed study. It seems certain that in this field the expert plant pathologist might readily point out weak points or practices, the correction of which would fully repay the expense of such studies. The seed producers need our assistance, and we in turn need theirs in solving these problems.

SEED DISINFECTION

Space prevents any extended discussion of seed disinfection regarding which much has been published—particularly from the empirical standpoint. There has been much progress in seed disinfection since Arthur and Bolley introduced the formaldehyde method. Recently, the dust treatments have been renewed with considerable success and still more recently have come the organic mercury compounds, the phenolic acids and the chlor-phenol compounds. The list of these newer compounds is increasing rapidly and a number of them have given promise of worth. Certain of these apparently stimulate the germination of seeds as well as acting as fungicides. The so-called electrical treatment of seeds has not given, under experimental tests, the results claimed by its originators, but a more careful study of the effect of electricity upon seed germination and its possible fungicidal action is needed. The heat treatments, both dry and wet, need further study and probably many materials not yet tested have possibilities of use for such purposes. The work of Braun on the physiology of seed treatment needs to be extended. However, these phases of the problem are advancing more rapidly than the more fundamental phases and we may be assured that, once the underlying principles are worked out, the remedy will be forthcoming.

LEGAL CONSIDERATIONS

The matters of exclusion of plant diseases under quarantine have been discussed by W. A. Orton in several papers. While the grounds for excluding many plants and plant products are fully justified the work of the various quarantine agencies of the different nations has been hampered in the case of seeds because of the general lack of specific information regarding seed-borne parasites. Action has been taken in a number of cases by Great Britain and in a very few cases by the United States, but if specific information was available undoubtedly we would be protected much further by adequate restrictions. At the present time we have six quarantines against foreign countries which are aimed in part or whole against seed-borne parasites. There are practically no interstate restrictions on seed-borne parasites except in California. Galloway has very clearly stated the problem from the standpoint of the office of Foreign Seed and Plant Introduction of the U. S. Deparment of Agriculture.

COOPERATION AND COORDINATION IS NEEDED

We can not hope to attack this problem in any general way without the cooperation of the seed producers. We need this cooperation to carry out the preliminary surveys which should be made, as well as in securing the funds which would be required to finance the work. We need the cooperation of the seed analysts, particularly those who have been trained in the technique of culture methods and seed germination. Without their assistance it would require more time and funds to work out what they already know and to duplicate the special equipment of the seed laboratory. Plant physiologists and chemists are needed in the problem, and in fact it would be necessary to organize the project on such a basis that scientists in any line could be called in to aid in solving the various phases of this problem.

We also need more complete coordination of the restrictive measures existing between nations. Inspection laws should be more uniform, international plant disease surveys should be organized and a general effort made to restrict in all feasible ways the further distribution of plant diseases, whether by seed or in any other way. Some of these points already have been given preliminary consideration by the International Phytopathological Commission which met at Rome in 1913, but the various expressions of that commission have not yet been crystallized and brought into effect. Further efforts to bring about some such permanent organization to deal with the international aspects of these problems should be made. Whether it will be possible to accomplish such a goal in the near future may appear doubtful. There is a feeling that such movements must follow public sentiment and this elusive thing moves slowly in regard to scientific matters, especially when dealing with agricultural problems. This may be our own fault, and I am thus led to mention the educational features of our research

problems. Many of us have been content to work out our problems in the laboratory and perhaps publish the results, and let the matter rest there. There is nothing startling to the public mind in the agricultural field, such as occurs in the engineering industries or in the sciences of physics and chemistry. Agriculture seems slow, inactive and dull compared with these other fields. We must, therefore, push forward more rapidly the educational campaign in order to more generally focus public opinion on our problems. Humanity needs to have these problems solved. They are more important than air transportation, wireless communication and the hundred other things which humanity discusses daily, but how long will it take us to convince the human race of this fact?

CLAYTON ROBERTS ORTON
THE PENNSYLVANIA STATE COLLEGE

THE AMERICAN PSYCHOLOGICAL ASSOCIATION[1]

WHEN I asked the president of your society for suggestions on this toast, he said there were only two rules that would be strictly enforced. In the first place, he thought you would not stand for more than 10 or 15 minutes from each of us, and in the second place he was sure it would not be safe for us to inflict our presidential addresses upon you. I told him that, in view of the time limit, the second injunction was entirely unnecessary, as no one ever heard of a ten-minute presidential address. In view of the "blue laws" that your president has laid down, I can only say a few words about the American Psychological Association and the work of its members.

The association was founded in 1892 by G. Stanley Hall, who was made its first president. It is one of the smallest of the national scientific societies. Its membership of 500 looks very insignificant, indeed, in comparison with the 15,000 of the American Chemical Society or the 75,000 of the American Medical Association. There are several reasons for our scanty numbers.

In the first place, although psychology of a sort has a very ancient history, and, as the science of magic, was the parent of medicine, chemistry and astronomy, psychology as an experimental science is hardly more than a half century old.

In the second place, the ranks of psychologists have been seriously depleted by the fact that so many have been called to university presidencies, though why any one should be willing to give up the delights of psychology for the worries of a university president is a little hard to understand. Among those who have seen it otherwise are the presidents of Yale, Cornell, Northwestern, Indiana, Kansas and a half dozen other universities and colleges. These men have at least proved that the psychologist is not afraid of a dangerous occupation!

We used to lose a good many of our members to philosophy. To-day we are more likely to lose them to biology, medicine, education, social science or business administration. As an illustration of the catholicity of the psychologist's interests and contacts, I may mention the fact that this year one of our members (Cattell) heads the American Association for the Advancement of Science, and another (Troland) the American Optical Society. The psychologist's work is leading him into such a variety of fields that his science is becoming ever harder to delimit. As Cattell recently expressed it, you can only define psychology as that which the psychologist works at.

But to resume my apology for our small numbers. I want to make it clear that the trouble is not due to any dearth of psychologists. I am sure there are more psychologists on Main Street, in Los Angeles, than there are chemists in the whole United States! Paradoxical as it may seem, it is precisely because there are so many psychologists that the American Psychological Association is so small. In order to reduce undesirable competition we have had to raise the bars higher than any other scientific body has found necessary. Not even the holder of a Ph.D. degree in psychology from the best university is assured of admission. He must also hold a respectable position in psychology and must prove by continued publication that he is genuinely interested in research. We do not dare to accept every bright graduate student of psychology, much as could be said about the inspiration this would bring to the young worker. If we did so, we might soon have a number of our members scattered over the country reading palms and practicing psychoanalysis at so much per palm and psyche. Hence the bars, which perhaps are even higher than necessary. Our membership committee is sometimes dubbed the "exclusion committee."

Now the psychologist must compete not only with the thousand and one kinds of professional fakirs, but also with everybody else, for all of us have practiced psychology from infancy up, including mind-reading, the psychology of suggestion, and the psychology of salesmanship. The boy runs away on Sunday to go swimming, slinks home, reads his father's mind from the look in his eye, and discreetly retires behind the barn. Even mental tests, which are often supposed to be a recent development,

[1] A toast at a dinner given by the Sigma Xi Society of Stanford University in honor of Stanford presidents of national scientific bodies.

are anything but new. One has only to recall Solomon's test of the rival claimants for possession of the disputed child. In fact, every one has practiced setting conditions to see how others would react to them, and this is the principle of the mental test.

The fact that everybody is something of a psychologist by necessity makes trouble for those of us who are psychologists by profession. We can hardly say anything about human nature but that some one will "up" and dispute it. Sometimes we envy the chemist or electrical scientist or astronomer in the fact that they have so much less competition from the layman. If you do not believe the astronomer who tells you that on a given day and hour and minute the moon's shadow will eclipse the sun over a certain area, all you have to do is to go there and see for yourself. When you have seen the eclipse appear at the very second it was predicted, you will be ready to believe the astronomer if he tells you it was caused by the shadow of Gabriel's wings. And if you don't take any stock in the electrical scientist's dicta about super voltage, all you have to do is to go to his laboratory and touch a little of it. If you are not convinced, I dare say you will at least be silenced.

But the psychologist, too, is gradually discovering a few constants in his phenomena and is thereby beginning to learn the game of prediction. It is already possible to predict with considerable accuracy for a six-year old child what I. Q. he will have at the age of sixteen, and roughly what the final limits of his educability will prove to be. It is possible after a few hours' study of a youth one has never seen before to make forecasts of considerable value with respect to the amount he will be able to accomplish in music, mathematics, mechanics or literature.

People are gradually finding out that this is true, with the result that a great change has come about in recent years in the status of the psychologist. A few decades ago he was regarded by the average person as at best an armchair theorist and at worst only a harmless crank. But now that psychology has tested and classified nearly two million soldiers; has been appealed to in the grading of several million school children; is used everywhere in our institutions for the feeble-minded, delinquent and insane; is appealed to by congressmen in the reshaping of national policy on immigration; is furnishing high-powered explosives for the social reformers of one wing, while serving at the same time as the target drawing the hottest fire from the other wing—no psychologist of to-day can complain that his science is not taken seriously enough.

In fact, we are not infrequently embarrassed by what people expect of us. Here are a few samples of problems that have been put up to me in the last sixty days:

(1) A business man has absent-mindedly mislaid some important papers and is unable to locate them. Can we, by means of hypnosis or crystal gazing, reinstate the facts in his memory?

(2) A boy of six has mastered the work of the first three school grades without instruction. The parents are afraid he is going to be a prodigy; what can they do about it?

(3) A boy of normal intelligence and superior environment steals, lies and runs away. Can we cure him by suggestion?

(4) A genius in Washington, D. C., has evolved an idea— *The Great Idea*— which, to use his words, "will cure all the ills of mankind except dying." Can we help him sell it to a long-suffering world?

(5) A woman student, a typist, is constantly obsessed by motor imagery of her fingers playing over the keys of the typewriter. She goes to class, tries to listen to the lectures, but can think of nothing except the feel of her fingers running over the keyboard. The harder she tries to stop it, the worse it gets. It is in the back of her head every moment, whatever she is doing. Can we get it out?

(6) A promoter tries to sell me stock in a new factory and is greatly humiliated by his failure. It must be due to my greater knowledge of psychology. Will I not put him in touch with the latest thing in the psychology of salesmanship so that he may have better success next time?

A good many of the problems put up to us are entirely legitimate from a scientific point of view; perhaps a majority are. Nearly every human problem, whether in education or business or politics or social reform, has its psychological aspect. The keynote of the last century was progress in the material sciences. Cattell suggests that the keynote of the next should be progress in the direction and control of human behavior. He believes that economic productivity can again be multiplied by two or three by the possible developments of psychological science.

The purpose of the American Psychological Association is to further the development of psychology as a science. As a result of its high admission requirements, 90 per cent. of its members are engaged in research. Perhaps you would like to know what kind of research. Forty years ago it would have been book research or armchair speculation. Now, of course, it is experimental. A census taken in 1920 showed that approximately half of those engaged in research were working along lines that might be classed as pure psychology, the other half in applied psychology, including educational, industrial, social and pathological psychology. By 1923

approximately 60 per cent. of our members were doing work in the field of mental tests.

Naturally, there are some of our members who deplore the modern emphasis upon applied psychology. They are prone to classify their colleagues into two categories, the pure and the impure. I think they overlook the fact that even pure science often grows fastest when the workers are moved by the dynamic incentive to human service. We may well remember that it was in researches on such homely practical problems as chicken cholera, swine fever, rabies, the diseases of silkworms and the manufacture of vinegar that Pasteur created out of hand the science of bacteriology. Accordingly, I see in the fact that psychology is being brought down from the clouds and made useful to men not the threatened degradation of a once pure and holy discipline, but the promise of a fuller science, one that will better deserve a place in the honored circle of its elder sisters.

LEWIS M. TERMAN

STANFORD UNIVERSITY

SCIENTIFIC EVENTS

OXFORD EXPEDITION TO THE ARCTIC

A BRITISH Arctic expedition, according to the London *Times*, is shortly sailing from Newcastle. The expedition has been organized and will be led by Mr. George Binney, who was secretary of the Oxford University Spitzbergen Expedition in 1921 and leader of last year's Oxford Expedition.

Two ships have been chartered, a 300-ton Norwegian whaler, the *Polar Bjorn* (Polar Bear), of Tromsö, and a small Norwegian sealing sloop. A seaplane specially designed for Arctic reconnaissance work has been constructed.

Oxford University has given its name to the expedition, which also has the support of the Royal Geographical Society and the Air Survey Committee of the War Office and of the Air Ministry. The primary objective of the expedition is to explore North Eastland, a large island, 90 miles square, which lies to the northeast of the main Spitzbergen Island. Two previous attempts have been made to explore it; the first in 1873, by the Swedish explorer Nordenskiold, who was only partially successful, and the second by the ill-fated German expedition of 1912, which perished in the attempt.

In addition to the main purpose of the expedition, other objectives are to beat the "farthest North" record of sailing in navigable waters (latitude 81.40 approximately) and to investigate and explore to the northwest of the Franz Josef Archipelago, where practically no work has ever been attempted and where there is reason to suppose unknown land exists. It is for this purpose that the second ship has been chartered.

Colonel J. E. Tennant is to lead the sledging party in North Eastland. Captain Helmar Hansen, who was at the South Pole with Amundsen, is going as "dog driver." Major Sir Ian Colquhoun is another member of the sledging party. The War Office have loaned Lieutenant Aldous, R.E., to conduct the ground survey. Other members of the expedition are Mr. H. Clutterbuck, Mr. R. Thornycroft, Mr. Relf, surveyor to the last expedition, Mr. K. S. Sandford, Burdett-Coutts, scholar in geology at the university, and Mr. Rankin, ornithologist and bird photographer.

RESOLUTION ON DESTRUCTION OF VERMIN AND PREDATORY ANIMALS

THE following resolution was unanimously adopted by the American Society of Mammalogists at the sixth annual meeting of the society, held in Cambridge, Massachusetts, on April 16:

WHEREAS, Active propaganda for the destruction of so-called "vermin" and predatory animals is being carried on throughout the country; and

WHEREAS, Much of this is advanced by arms and ammunition interests, and by others financially benefited, and mainly by persons only superficially acquainted with these animals, or by misinformed persons; and thus much serious injury is done to wild life conservation; therefore, be it

Resolved: First, That the American Society of Mammalogists, which is a professional society of international membership of students of wild life, including practically all field naturalists who are primarily interested in mammals, points out the danger which lies in such propaganda;

Second, That there exists no real occasion for a nation-wide campaign for the destruction of predatory animals, and that this is particularly unwise because it furnishes a pretext for illegal hunting out of season;

Third, That copies of these resolutions be forwarded to other interested organizations, game and protective associations, and to all federal and state agencies concerned.

HARTLEY H. T. JACKSON,
Corresponding Secretary

THE YELLOWSTONE SCHOOL OF NATURAL HISTORY AND BIOLOGICAL STATION

THE region of Yellowstone National Park contains a wealth of material of interest in the natural sciences. The splendid pioneering work of Hayden on the geology of the region has never been properly followed up, and virtually the whole of the work waits to be done again. The vulcanology of the geyser and hot springs basins, as well as the paleontology of the fossil forests, exist at present only as the barest

beginnings, though hopeful projects are on foot. Beginnings in botany were made by Coulter in 1872, and Nelson later carried on further explorations and collections; but much remains to be done. Mammalogy, ornithology and entomology still afford wide opportunities. And what is perhaps the most fascinating of all, the ecology of the geyser basins, with their unique combination of thermal, chemical and altitudinal factors, is a field still absolutely virgin.

Hitherto the park area has been inaccessible to most scientists, for, although the National Park Service has always made it a part of its policy to assist scientific work in every way possible, the aid so given has been of necessity limited because the main efforts of the Park Service must be expended for the benefit of the traveling public in general. A project is now on foot, however, involving cooperation between the National Park Service and private generosity, that promises to establish at Yellowstone National Park an important center for research and field study in the geological and biological features of this region.

The National Park Service, through Director Stephen T. Mather and Superintendent Horace M. Albright, is offering the use of a large stone building in good repair and needing only minor alterations to make it into an excellent laboratory and class room building, with room to spare for the housing and feeding of approximately one hundred persons. With the building go grounds of sufficient extent for the development of ornamental planting and for a botanical garden in which to arrange a collection representative of the flora of the park. The present park museum and library will be moved into the new quarters, and will be available for the use of students. This building has been made available without cost and upon conditions characteristic of the generosity and public-spirited policy of the National Park Service.

The institution will be known as the Yellowstone School of Natural History and Biological Station. Funds for its operation during the initial quinquennium are now being collected. Scientists interested in the facilities to be gained by this station are requested to give assistance by sending for use in its library copies of their publications in botany, zoology, geology, paleontology, forestry, ecology and related subjects. Funds for the endowment of research, either as gifts or as fellowships from universities, are desired. It is expected that the school will be operated on an expense basis until further endowment for research is obtained.

Communications should be addressed to Dr. R. B. Harvey, acting director, University of Minnesota, Minneapolis.

FRANK THONE, R. B. HARVEY,
WM. J. CRIBBS, H. S. CONARD

THE AMERICAN CHEMICAL PRIZE

THE Allied Chemical and Dye Corporation in 1922 instituted an annual prize of $25,000 to reward the chemist, residing in the United States, who in the opinion of a properly constituted jury has contributed most to the benefit of the science and of the world, and on August 30 requested the American Chemical Society to administer the award. At the Milwaukee meeting of the society on September 10, the following vote was passed:

The American Chemical Society received at its last annual meeting the announcement of a monumental gift for the promotion of chemistry in America—an annual prize of $25,000, founded by the Allied Chemical and Dye Corporation. The council reaffirms its acceptance of this gift with deep appreciation of its importance. The committee to whom this matter was referred having agreed that the name of the prize shall be The American Chemical Prize (Founded by the Allied Chemical and Dye Corporation) the council heartily concurs in this recommendation. The committee also recommends that the jury of the award be a self-perpetuating body consisting of seven members, five of whom shall represent the American Chemical Society and two shall be named by the Allied Chemical and Dye Corporation. This the council also approves and empowers its committee, composed of Edgar F. Smith, Charles F. Chandler, Ira Remsen, Frank P. Venable and Theodore W. Richards, to select the initial five members representing the American Chemical Society.

The council further approves the following supplemental recommendations of the committee:

The prize shall be awarded annually to that chemist, man or woman, a citizen or a resident of the United States of America at the time, who in a certain year or through a period of years has made a contribution of high merit or in some marked way has promoted the betterment of society through the science of chemistry.

Chemists engaged in any division of their science, including the teaching of chemistry, shall be eligible for the prize.

The jury of award shall select the recipient of the prize. It shall formulate the rules and regulations governing the award of a prize.

The prize shall be presented at an annual meeting of the American Chemical Society. The recipient of the prize will be expected to receive the prize in person and shall be invited to deliver an address before the society, his expenses in attendance at the meeting to be defrayed by the Allied Chemical and Dye Corporation.

The following correspondence is now published in *Industrial and Engineering Chemistry*:

ALLIED CHEMICAL AND DYE CORPORATION
61 Broadway, New York

April 16, 1924

Office of Chairman
Dear Dr. Smith:

We are writing you pursuant to the understanding

which you, Mr. Weber, and the writer had when you were last here, on February 28th, that we would let you know before the 21st of this month our conclusion as to availing ourselves of the American Chemical Society's good offices in connection with the administration of our proposed award for outstanding accomplishment in the field of chemistry, first called to your attention a year ago last September.

As you know, we have had in mind from the outset that, in view of the society's mutual interest with us in the encouragement and reward of unusual technical achievement in the science of chemistry, the society's active cooperation in connection with our contribution to that end would be helpful. We face the fact, however, that, in the rather long course of our approaches toward such cooperation, your own splendidly earnest and understanding work as the society's representative has, unfortunately, not resulted, as we had hoped, in the society's formulation of a plan of administration which could appropriately be put into effect; and, being anxious to have the award made effective as promptly as practicable, we have concluded that, under the circumstances, this can best be accomplished by withdrawing our original suggestion to you that the society share with us the responsibility of creating the method of procedure and organization for administration thereof.

Please, therefore, accept this letter as such withdrawal, and at the same time rest well assured of our thorough appreciation of your most generous and conscientious efforts in the matter.

Very truly yours,

(Signed) WM. H. NICHOLS, *Chairman*

DR. EDGAR F. SMITH, PRESIDENT,
American Chemical Society,
Care of University of Pennsylvania,
Philadelphia, Pa.

TO THE PRESIDENT AND COUNCIL OF THE AMERICAN CHEMICAL SOCIETY:

Your committee appointed last September to consider the status of the prize offered to the American Chemical Society by the Allied Chemical and Dye Corporation begs to submit the following recommendation:

In consultation with the officials of the Allied Chemical and Dye Corporation, we have found that this corporation no longer desires the cooperation of the American Chemical Society in the administration of the prize which they have recently announced. That being the case, we suggest that the American Chemical Society should pass a vote relinquishing the acceptance of the administration of this prize. At the same time we hope that the society will express deep appreciation of the purpose of the corporation in establishing a prize intended to redound to the good of chemistry in America and to the welfare of American chemists.

CHARLES F. CHANDLER,
IRA REMSEN,
THEODORE W. RICHARDS,
FRANCIS P. VENABLE,
EDGAR F. SMITH, *Chairman*

April 19, 1924

THE SEVENTEENTH ANNUAL CONFERENCE ON THE WEIGHTS AND MEASURES OF THE UNITED STATES

THE Seventeenth Annual Conference on the Weights and Measures of the United States was held at the Bureau of Standards May 26, 27, 28 and 29. The attendance numbered about 175, of whom 100 were weights and measures officials, and the remainder manufacturers, railroad officials and others interested in weights and measures work. A number of matters were considered, among them that of the uniform marking and filling of milk bottles, specifications and tolerances for vehicle tanks used for measuring such materials as gasoline, and standards for bread loaves.

Resolutions of appreciation and a gold medallion were presented to Dr. S. W. Stratton, former director of the Bureau of Standards, and president of the conference, and now its honorary president.

The following officers were elected for the ensuing year: *President,* George K. Burgess, of the Bureau of Standards; *first vice-president,* I. L. Miller, of Indiana; *second vice-president,* Thomas F. Egan, of Connecticut; *secretary,* F. S. Holbrook, of the Bureau of Standards; *treasurer,* George F. Austin, of Detroit, Michigan.

SCIENTIFIC NOTES AND NEWS

SIR WILLIAM J. POPE, professor of chemistry in the University of Cambridge, has been elected a corresponding member of the Academy of Sciences of the Institut de France.

THE Royal Academy of Sciences, of Bologne, has awarded the international prize in physiology to Professor Otto Loewi, of the University of Graz, for his work on the innervation of the heart.

THE gold medal of the Royal Astronomical Society has been awarded by the council to Professor A. S. Eddington and was presented at the meeting of the society on June 13.

PROFESSOR R. A. MILLIKAN, of the California Institute of Technology, delivered the Faraday lecture given in connection with the chemical societies, London, on June 12, his subject being "Atomism in modern physics." Afterward Dr. Millikan was presented with a medal bearing the effigy of Faraday which had been especially made to commemorate the occasion.

DR. SHIRO TASHIRO, an associate professor of biochemistry in the University of Cincinnati College of Medicine, will leave soon for Japan to receive the Gakushiin prize from the Imperial Academy of Arts and Sciences. The bestowal of this prize in Japan is considered a national event.

THE degree of doctor of science has been conferred on Maximilian Toch, of New York, by the Peking University, at the instance of the Chinese government. This is the second time Dr. Toch has been honored by that government, at whose invitation Dr. Toch is lecturing in China.

THE University of Maine conferred the honorary degree of doctor of science on Dr. Francis G. Benedict, director of the Nutrition Laboratory of the Carnegie Institution, where he made the commencement address in June.

NEW YORK UNIVERSITY has conferred the degree of LL.D. on Professor Michael Pupin, of Columbia University.

THE Case School of Applied Science has conferred on Dr. George K. Burgess, director of the Bureau of Standards, the honorary degree of doctor of engineering.

IT is announced that next week Oxford University will confer the honorary degree of D.Sc. on Sir Humphry D. Rolleston, M.D., president of the Royal College of Physicians of London.

THE Buenos Aires Spanish Culture Institution, a society organized to further scientific research through granting awards, has granted to Ramón y Cajal its first prize this year. The money awarded included interest on funds collected in Argentina on Cajal's retirement and amounted to 32,759 pesetas (about $4,400). The University of Paris has also appointed Dr. Cajal an honorary physician.

WILSON POPENOE, agricultural explorer of the U. S. Department of Agriculture, has been awarded the silver medal of the Société Nationale d'Acclimatation de France, in recognition of his work on the botany and culture of tropical economic plants.

DR. ADOLF LORENZ, the noted Austrian surgeon, celebrated his seventieth birthday on June 8. A life-sized plaque was unveiled in the general hospital in Vienna, to commemorate his achievements.

DR. WILLIAM H. BROWN, professor and head of the department of botany of the University of the Philippines, has been appointed director of the Bureau of Science at Manila, to succeed E. D. Merrill, who is now dean of the college of agriculture of the University of California.

DR. CHARLES SHEARD has accepted the position of chief of the section of physics and biophysical research at the Mayo Clinic, Rochester, Minn. He was the first professor and director of the work in applied optics at the Ohio State University.

THOMAS A. JAMES, curator of the State of Maine Museum and state ornithologist, has been appointed assistant in ornithology and preparator in the Peabody Museum for the next academic year.

THE governor of New York state has announced the appointment of Dr. Frederick Fuller Russell, of Brooklyn, as a member of the Public Health Council to take the place of the late Dr. T. Mitchell Prudden.

ALEXANDER JAY WURTS, research professor of electrical engineering at the Carnegie Institute of Technology, is retiring from active duty at Carnegie at the end of this year.

ARTHUR T. UPSON, chief of the section of industrial investigations of the U. S. Forest Products Laboratory at Madison, Wis., has tendered his resignation, effective on June 30, to join the staff of the National Lumber Manufacturers Association.

PROFESSOR D. DIXON, head of the department of anthropology at Harvard University, will sail for the South Sea Islands and Australia, with the idea of doing research work and excavations on some of the reported ruins in those islands. Professor Dixon will be gone until next January.

DR. H. A. GLEASON, of the New York Botanical Garden, left for England on May 3, with the expectation of devoting three months to the study of South American plants in the herbaria of the Royal Botanic Gardens at Kew and of the Museum of Natural History in Paris. He will attend the British Botanical Congress, to be held in London in July.

JOSEPH M. VALENTINE, assistant in the zoological department of the Peabody Museum, has just returned from a collecting trip to the mountains of western Panama in company with members of the staff of the American Museum of Natural History. The purpose of the expedition was to secure specimens of the bird life of this region, which has been but little explored ornithologically. The bird skins obtained are for the American Museum, but Mr. Valentine brought back a considerable variety of other groups of animals to add to the collections of the Peabody Museum.

DR. C. W. ANDREWS, F.R.S., of the British Museum of Natural History, died on May 25, aged fifty-eight years.

SIR ASUTOSH MOOKERJEE, formerly vice-chancellor of the University of Calcutta, founder-president of the Calcutta Mathematical Society, and twice president of the Asiatic Society of Bengal, died on May 25, aged fifty-nine years.

THE death of Dr. Henry Parent, former president of the Ophthalmologic Society of Paris, at the age of seventy-five, has been announced.

DR. JOSEPH HENRY O'CONNELL, associate professor of diseases of the ear at the New York Post-Gradu-

ate Medical School, died on May 19, aged fifty-one years.

MORE than 150 delegates from Europe, including 18 leading mathematicians of French universities, already have agreed to attend the seventh International Mathematical Congress to be held in Toronto next August, concurrently with the meetings of the British Association for the Advancement of Science. The Canadian and Provincial governments have appropriated $50,000 toward expenses of the congress.

THIS year, for the first time, French and German men of science (in addition to lecturers from Great Britain and almost all the European countries) will meet on a common platform in Vienna under the auspices of the Vienna International Summer School. The lectures will be delivered in English, French and German, and the committee are providing for conducted tours through Vienna and its environment. The school will be held during the period September 2 to 20.

DURING April and May the following lectures were given at the Royal Institution in London: Professor Barcroft gave a course of four lectures on "The effect of altitude on man." The Tyndall lectures were delivered this year by Major M. S. Tucker, director of sound ranging in the army, on "Acoustical problems." Mr. F. Balfour Browne gave two lectures on "Social life among insects"; Dr. E. V. Appleton delivered two lectures on "Atmospheric interference on wireless telegraphy," and Dr. C. G. Seligman two lectures on "Divine kings and rainmakers of the Sudan" and "The veddas of Ceylon."

A CONFERENCE on science and labor was held at the British Empire Exhibition on May 30 and 31. The conference, which was arranged by the British Science Guild in cooperation with the National Joint Council of the Trades' Union Congress and Labor Party, was opened by the prime minister. There were five sessions, the subjects of discussion being: (1) The place of science in government; (2) Scientific research in relation to industry (3) Cooperation of science and labor in production; (4) Science and the human factor; (5) Science in educational organization.

THE first plant breeder's conference in India met on April 14, in the botanical laboratory of the college of agriculture, Poona, Bombay, under the presidency of Dr. W. Burns. It was decided to hold the conference annually and to meet next year in Surat.

DR. FRIEDRICH DANNEMANN will deliver this summer at the Universities of Bonn and Cologne a series of lectures on the history of science which, though primarily designed for students of physics and chemistry, will be open to others who are interested in the development of science and the scientific arts and in the broader aspects of their relation to more general human affairs. These lectures will cover the entire historical period, and will emphasize the historical and actual interrelation of the sciences and their influence on the progress of civilization.

IT is planned to build and endow at Princeton University new chemical laboratories at a cost of two million dollars.

THE British Empire Cancer Campaign is appealing through the British Red Cross Society's organization for funds to endow and subsidize research on the causes and treatment of cancer. Grants amounting to £2,500 each have already been made to the research department of the Cancer Hospital and the cancer research department of the Middlesex Hospital.

THE late William Prescott has bequeathed £20,000 to the University of Liverpool to found a chair of agriculture or a chair for the furtherance of one or more of the following subjects: The chemistry of agriculture; the cultivation of land; the care, breeding and raising of crops; the diseases of crops; or any other subject connected with agriculture.

THE Eunice Rockwood Oberly Memorial Fund Committee of the American Library Association announces the foundation of a prize in memory of Eunice Rockwood Oberly, formerly librarian of the Bureau of Plant Industry of the U. S. Department of Agriculture.

THE centenary of the birth of Lord Kelvin occurs on June 26 of this year. *Nature* states that on that date the Institution of Electrical Engineers, of which Lord Kelvin was thrice president, will hold a centenary conversazione. At the University of Glasgow, the Kelvin centenary will be celebrated on June 25, which is commemoration day. The honorary degree of doctor of laws will be conferred on Mr. Ramsay MacDonald, the prime minister, whose wife was a grandniece of Lord Kelvin. It will also be conferred on Sir James Bell, who as lord provost was chairman at the jubilee banquet to Lord Kelvin in June, 1896, and on Dr. Alexander Russell, president of the Institution of Electrical Engineers, who is to give the Kelvin oration. The official celebrations, in which practically every scientific and engineering society and institution in Great Britain will participate, will be held on July 10 and 11. This late date was decided on so as to allow the many hundreds of foreign men of science and engineers who will then be in London the opportunity of participating. On July 10 Sir J. J. Thomson will deliver a memorial oration of Kelvin before the world power conference. On the evening of the same day, the president of the Royal Society will give an official reception. On July 11 Lord Balfour will take the chair at the Kelvin centenary banquet.

ON May 19 the advisory committee, appointed by the secretary of agriculture to guide the activities of the Lake States Forest Experiment Station, met in Duluth to consider the problems confronting timberland owners in the three Lake States and to pass upon the program of investigations proposed for the coming year.

As a part of a comprehensive plan to improve the industries of Cincinnati, the Commercial Club of Cincinnati is financing a scientific study of raw materials in Ohio and other states which may be commercially tributary. The work is to be done in the University of Cincinnati, largely by the staff of the department of geology and geography, suitably increased for this purpose. After collecting available data, supplementary field work will be necessary. Provision is also made for technological work. The work will continue several years and will cost at least $50,000.

UNIVERSITY AND EDUCATIONAL NOTES

HARVARD UNIVERSITY has been given $200,000 for the construction of a new administration building, by Arthur Lehman, a New York banker. In addition it is announced that a large part of the new endowment fund has been raised. Of the $3,000,000 allotted to the division of chemistry, $2,080,000 has been specifically donated, and of the $2,000,000 desired for the division of fine arts, $1,145,000 has already been obtained.

THE Rockefeller Foundation has made a grant of $500,000 to the Medical Faculty of McGill University. Dr. Jonathan C. Meakins, Christison professor of therapeutics and professor of clinical medicine at Edinburgh University, has been appointed director of the medical clinic to be established in the Royal Victoria Hospital and he will also be professor of medicine and director of the department of medicine of McGill University.

DEAN EDWARD MORGAN LEWIS has been elected acting president of Massachusetts Agricultural College to take the place of Kenyon L. Butterfield, who has resigned to become president of the Michigan Agricultural College.

PROFESSOR G. D. BIRKHOFF, of Harvard University, will be exchange professor at Pomona, Colorado and Grinnell Colleges during the first half of the academic year 1924–25.

DR. HERBERT W. ROGERS, at present engaged in research work for the National Research Council at the University of Minnesota, has been appointed associate professor of psychology at the University of Vermont.

DR. THOMAS B. HOLLOWAY has been elected professor of ophthalmology at the University of Pennsylvania School of Medicine, to succeed Dr. George E. de Schweinitz.

AT the University of Arizona Dr. Paul S. Burgess, formerly with the Rhode Island Experiment Station, has been appointed professor of agricultural chemistry, and John B. Cunningham, formerly professor of metallurgy and head of the department of metallurgy at the Michigan School of Mines, has been appointed professor of metallurgy.

DR. ALBERT H. BYFIELD has resigned from the position of professor of pediatrics in the school of medicine of the University of Iowa, and is planning to spend the coming year in study abroad.

THE University of Cincinnati announces the appointment of Charles H. Behre, Jr., formerly instructor in geology at Lehigh University, to the position of assistant professor in the department of geology and geography. His duties will include much of the work in connection with the recently instituted survey of raw materials in the region commercially tributary to Cincinnati, together with some teaching in the university. Dr. Geoffrey Gilbert, formerly assistant in the department of geology at Harvard University, has been appointed to fill the position at Lehigh University vacated by Mr. Behre.

DISCUSSION AND CORRESPONDENCE

THE BONES OF RAFINESQUE

THE name of Constantine Rafinesque is well known to all students of natural history in America. He was born in Constantinople in 1785, of a French father and German mother (Schmaltz). He wrote on the fishes and plants of Sicily. Coming to America in 1802, he wandered widely on foot in Kentucky and neighboring states, loading his "pack under which a pedlar might groan" with plants and shells, and his notebooks with records of fishes and birds, accompanied by execrable drawings, from which he too often drew up his descriptions. A man of great industry, rare insight, wide-ranging knowledge and interest, and distressingly careless as to details. One of the early apostles of evolution, he found no one to listen to his arguments, profound in fact, but often most casually stated. For thirteen years (1813 to 1826) Rafinesque was professor in the then new, but now old, Transylvania University at Lexington, Kentucky, where he found a friend and defender in John Clifford, one of the very few who could know him at his best, in a community which mostly doubted his sanity.

He died in Philadelphia in 1840, in abject poverty

and was buried in the pauper lot of Ronaldson Cemetery. Only the intervention of two or three students saved him from the medical college. In 1919 a stone was placed over his grave by Mr. Henry C. Mercer, of Doylestown. This reads:

CONSTANTINE S. RAFINESQUE
Naturalist and Philosopher
Born, Constantinople, 1785
Died, Philadelphia, Sept. 18, 1840

To do good to mankind has ever been an ungrateful task.
The work of God to study and explain
Is happy toil and not to live in vain.

Other epitaphs suggested by Rafinesque himself were these:

Un voyageur dès le berceau
Je le serai jusqu'au tombeau.

Linné, grand génie, il a choisi pour guide.

Quite recently Transylvania has interested itself afresh in the most famous of its line of professors. Mrs. Charles F. Norton, librarian, sent to Philadelphia for a photograph of the headstone, intending this as a gift to the Rafinesque Botanical Club of the university. It was found that the cemetery was to be turned into a public park. On learning this, Mr. James A. Spencer, a brother of Mrs. Norton, "expressed a wish that Transylvania, which had loved and honored Rafinesque, might have his body, which was buried in a neglected grave."

This plan was duly carried out in March, 1924, as I learn from Mrs. Norton, and the bones of the restless explorer now lie in the campus of Transylvania.

It is no longer true, as the present writer said forty years ago, in a biographical sketch of "A neglected naturalist," that "we know not even the place where he rests after his long journey."

DAVID STARR JORDAN
STANFORD UNIVERSITY

NAMING AND EXACT NAMING

IN SCIENCE, vol. 45, page 190, 1917, I called the attention of my colleagues to the need for more complete titles, suggesting that in biological papers the name of the animal studied be given. This is now more often done, but owing to the still frequent omission of this datum, the difficulty thus introduced in collecting the literature on a given animal is painfully evident to any one who has made the attempt.

I beg now to present a further request touching the name of the rat, an animal so largely used for a variety of biological investigations.

The term "white rat" has appeared not infrequently in recent titles, but this says nothing concerning the color of the eyes. If, for this, the term "albino rat" were employed, there could be no question as to the variety used, and some day this may prove to be important.

Further, several active laboratories now use the pied rat, not the albino. Though the pied rat is very close to the albino in many respects, yet there are differences between the two strains, and it will be of the greatest assistance in the more refined studies on this animal—studies which are already upon us—to know exactly the form employed, for it is increasingly evident in the biological field that before giving any results, the animal studied should be precisely named.

HENRY H. DONALDSON
THE WISTAR INSTITUTE,
PHILADELPHIA, PA.

THE SCIENTIST AND AN INTERNATIONAL LANGUAGE

AT the general meeting of the American Philosophical Society, held in April, it was my privilege to present a paper on "The scientist and an international language." This will appear in the *Proceedings* of that society; but as the subject seems to have attracted some attention on the part of scientists and of the public press, I should like to lay the matter before the members of the American Association for the Advancement of Science. My thesis is, that as the scientist is nowadays overworked by the necessity of learning a considerable number of languages in order to read the literature of his field, he needs a single international medium, in which publications intended for or deserving of an international clientele should be published; further, that Latin is the logical choice for this use.

Latin had such an international use until nearly the end of the eighteenth century, but by that time was displaced by English, French and German. Today, with the recrudescence of certain minor linguistic units and the increased nationalistic spirit of certain larger ones, we face a time when scientific publications of value may appear in perhaps twenty languages. The task even now has become too heavy, and many publications of value remain inaccessible or unknown to those who should be able to avail themselves of them. A common medium must be sought, either a modern language or Latin or an artificial language.

For the natural scientist, the *sine qua non* in his choice is that the international language should convey the thought with objective certainty. Any artificial language can show no such objectivity; but

Latin is unsurpassed in this respect. Further, the technical terminology of virtually all sciences in most of the modern languages (as well as the artificial languages) is drawn from Latin or from Latinized Greek; Latin, therefore, has the common international vocabulary of science. The inflections of Latin, though by some they are considered a disadvantage, in reality give a greater precision in the indication of the relations amongst the words than is possible in a language which has a minimum of forms and depends largely upon word order to show those connections. Finally, Latin is even to this day the international language of the zoologist and of the botanist in the names of animals and of plants, for the anatomist in his entire technical terminology, for the physician and the pharmacist in the writing of medical prescriptions, for the chemist in the names of the elements, etc.

Yet, naturally, whatever may be the international language used by the scientists, it will not be his sole medium of publication. Rather we should look to see, in the international language, only abstracts of arguments and results which have been published in other languages; some longer articles of truly permanent value; and those few books which are epoch-making in their fields.

Such, in brief, was my presentation. But my argument as to the advantages and the availability of Latin can be appreciated properly only in the full form of the paper; I could give here but the salient points. Naturally, I do not fancy that all scientists —and I am thinking throughout of those in natural and physical sciences—can now read, much less that they can write, Latin; few persons there are who can write for publication in other than their mother tongue. But all scientists now learn to read from one to ten foreign languages; and if there were an agreement, even though only a "gentlemen's agreement," that Latin should be the chief international medium, they would give Latin a preferred place in their study of foreign languages. The starting point for this alleviation of the scientist's toils might well be an international review expressed in Latin, containing summary accounts of publications in all lands and languages, which pertain to some one science or to some one group of kindred sciences.

I should be glad to enter into correspondence with those who are interested, whether or not they agree with me.

ROLAND G. KENT
UNIVERSITY OF PENNSYLVANIA

INSECTS IN THE CALIFORNIA TAR TRAPS

SEEPAGES and springs of petroleum from subterranean sources occur in many places in California and have existed at least since early Pleistocene time. As the oil meets atmospheric conditions the more volatile constituents pass away and leave a black, viscous, asphaltic tar. Many of these seepages are "alive" to-day and form slow moving streams with occasional pools of considerable size. The brilliant mirror-like surface of the substance looks strikingly like placid water and in this way has "fooled" the animals of the region for a geological period.

Mammals and birds particularly have been attracted to these apparent water holes probably most often to quench their thirst, take a bath or a rest on the quiet surface, but other times to feed on these same unfortunates. Once mired in the sticky tar, escape was practically hopeless and vast quantities of bones have accumulated in the more favorably located "traps." Most famous of these are the ones on Rancho la Brea in Los Angeles County. The birds and mammals of the Pleistocene have become well known from the collections made there and through their strangeness serve to illustrate forcibly the vast change in fauna which has taken place in the region.

Many other of these tar deposits exist in the state, and it is possible that some of them may rival the famous ones of Rancho la Brea as prehistoric traps. During a recent brief examination of one of these near the town of McKittrick, in Kern County, I was surprised at the enormous numbers of insects preserved beside bones of extinct mammals. Most of those seen in a hasty examination were beetles and in many cases the parts appeared to be disassociated but excellently preserved, even to the iridescent colors. It is not likely that this is the first observation of the occurrence, but attention is here called to it in hopes that entomologists may become interested in the comparison of the Pleistocene insect fauna of the region with the birds and mammals.

It would be well to add that the tar is just as effective in the capture of organisms to-day as it has ever been. In one canyon where there was a "live" seepage a small pool of tar not more than a dozen feet across was so thickly bestrewn with a species of large water beetle that a manufacturer of fly-paper would certainly look upon the sight with envy. In some places there is, therefore, in all probability, a practically continuous accumulation from at least early Pleistocene to the present time.

G. DALLAS HANNA
CALIFORNIA ACADEMY OF SCIENCES

SCIENTIFIC BOOKS

Biomathematics, being the Principles of Mathematics for Students of Biological Science. By W. M. FELDMAN, London, Griffin and Co. xix + 398 pp.

As W. M. Bayliss points out in his Introduction

to Feldman's "Biomathematics," students of biology are finding themselves to-day in need of mathematics for certain types of investigations. As few of those biologists now in middle life have any considerable knowledge of mathematics and as it is not even to-day widely recognized by those collegians who plan to specialize in biological or medical sciences that they will need mathematics, and as it is by no means certain that, even with a realization of the need, the desired parts of mathematics could be found in the collegiate courses offered by departments of mathematics, it is evident that there is at present and probably will for many years remain a place in biological literature for books that expound those principles and algorisms of mathematics which are of greatest importance for such students and elaborate the exposition with a larger variety of worked examples from these fields of science. Feldman's "Biomathematics" is one of the first books directed to meet these special desiderata and seems to be likely to succeed in meeting them.

The titles of the 21 chapters are: "Introductory," "Simplified methods in arithmetic," "A few points in algebra," "A few points in elementary trigonometry," "A few points in elementary mensuration," "Series," "The simple and compound interest laws in nature," "Functions, variables and constants," "Differentials and differential coefficients," "Maxima and minima," "Successive differentiations," "Integral calculus," "Biochemical applications of integration," "Thermodynamic considerations and their biological applications," "The use of integral calculus in animal mechanics," "Use of integral calculus for determining areas, lengths, volumes and moments of inertia," "Special methods of integration," "Fourier's theorem," "Differential equations," "Mathematical analysis applied to the coordination of experimental results," "Biometrics."

Whether the author might not have omitted some topics is a serious question. Fourier's series is presented without biological illustrations. And what are the occasions on which biologists or others must differentiate x^x? One may expect mathematicians to take an interest in the cute tricks of their trade and may excuse them for inserting in their texts artificial examples and methods suited to their solution, but in a book especially written for some class of non-mathematicians it would seem to be better pedagogy to eschew all methods which were not used in illustrative material of interest to the readers. In places Feldman's is too much a text on mathematics with illustrations from biology instead of an exposition of quantitative problems of biology with an explanation of their mathematical treatment (it is of course far easier to write the mathematical text). Still I know of nothing better for its intended clientele.

Edwin B. Wilson
Harvard School of Public Health

LABORATORY APPARATUS AND METHODS

CERTIFIED SAFRANIN

In accordance with the plan announced in Science for July 20, 1923 (Vol. 58, p. 41), the Commission on Standardization of Biological Stains has been extending its plan of certification of stains, the latest addition to the list of those certified being safranin. This certification, as stated in the earlier article, is issued only for the batch of which a sample has been tested and found satisfactory.

The procedure followed by the commission when asking for the submission of samples to be tested for certification is to furnish the companies with specifications, provided preliminary work has been done to show what these specifications should be; but otherwise to ask the companies to submit the samples which they think will be most satisfactory, assuring them that certification will be based on performance of the samples rather than upon their chemical composition. This second course was followed in the case of safranin, and upon the basis of those samples submitted which proved satisfactory, specifications have now been drawn up which will be used in the future as the basis for accepting samples for certification. The batches of safranin which are now being certified fulfil all these specifications in regard to performance. One of them, however, is of lower dye content than the commission will recognize in the future. The lower dye content of this sample, however, does not seem to make it less satisfactory as a stain.

The specifications that are now drawn up for safranin on the basis of the samples which have been found to be satisfactory and which will be applied to any sample hereafter submitted to the commission are as follows:

(1) Samples of safranin O must be of the type represented by Schultz No. 679 and on spectrometric analysis should have an absorption curve maximum at approximately 515 μμ as determined in a one cm layer by a spectrophotometer. Other dyes must not be present.

(2) Safranin samples to be certified by the commission must contain at least 75 per cent. total color as determined when reduced by titanous chloride in an atmosphere of carbon dioxide. One gram of the dye must consume at least 4.195 cc normal titanous chloride solution.

(3) The sample should prove satisfactory for histological use. No exact method for determining this can be given, but the sample must be submitted to

one or two experts in histological technic in order to get their judgment. Their judgment must be based to a considerable extent upon the behavior of the stain in the Flemming triple staining technic, in which it is used together with orange G and gentian violet. In other words, the stain must be of such a shade as to contrast well with both of these two other dyes.

(4) It must be understood that these standards refer to samples to be used for general histological staining. Special standards for safranin to be used for certain special purposes will undoubtedly be necessary. These standards, however, have not yet been determined.

At the present time permission to use the commission's label on the batches of safranin submitted has been given to three companies. Work is still pending on samples submitted by one or two other companies, so that the omission of some concern from this list does not prove that their safranin is necessarily unsatisfactory. The three samples so far approved fulfil the above specifications in every respect except total dye content; but the three samples vary somewhat in the amount of actual dye present. These three samples with their total dye content are as follows:

National Anilin and Chemical Company	90 per cent.
Empire Biochemical Company	87 per cent.
Providence Chemical Laboratories	55 per cent.

That one of those three samples which is below 75 per cent. in total dye content has given perfectly satisfactory results in the hands of the investigators who tested it. Nevertheless, purchasers must take its lower concentration into account. For this reason the commission is requiring that certified samples of safranin be labeled as to their total dye content. This will enable the purchasers to take the matter of concentration into account in making up solutions, and will enable them to make a fair comparison between the products of the different concerns.

Attention of biologists is again called to the fact that these stains do not have to be ordered from the companies listed above. Nearly all the regular dealers in biological supplies are planning to carry the certified stains as rapidly as the certification is extended to cover new products. It is possible, therefore, to order these stains from any laboratory supply house by specifying that certified stains are desired or by even specifying the company whose product is wished for if the purchaser has any preference.

H. J. CONN, *Chairman,*
Commission on Standardization of Biological Stains

GENEVA, N. Y.,
APRIL 1, 1924

STAINING WOODY TISSUES WITH SAFRANIN AND PICRO-ANILIN BLUE

THE use of safranin in combination with picric acid and anilin blue in the staining of woody tissues has been developed at the Forest Products Laboratory, and some excellent results have been obtained with certain kinds of woods. The triple stain herein described calls for safranin as a first stain, followed by a single solution containing picric acid and anilin blue.

Safranin is one of the most important of the coal-tar dye stains because of its selective properties, brilliancy and permanence. Picric acid, which is less well known in microscopy, is a yellow crystalline compound obtained variously, as by the action of nitric acid on phenol. Anilin blue is a basic derivative of the base rosanilin. Best results follow the use of pure chemicals from reliable manufacturers.

Stains are generally divided into two types, general and selective. The former acts on all the elements of a specimen while the latter takes effect on, and makes prominent, only some or parts of them. It is of value to the worker in microscopic anatomy to obtain this differentiation, as he is thereby able to trace and follow structural differences and relationships.

If the material to be sectioned is green, it usually requires no further treatment. If dry wood blocks are used, they should be prepared for the microtome by boiling for about thirty minutes or longer in water. Extremely refractory and hard woods should be immersed in commercial hydrofluoric acid (30–40 per cent.) for a few days and again boiled in several changes of water to wash out the contained acid, previous to cutting sections. The writer secured best results with sections 10–15 micromillimeters in thickness.

The safranin stain is prepared by mixing a saturated water solution of water-soluble safranin, and a saturated alcoholic solution of alcohol-soluble safranin. Equal amounts of these two safranin solutions are mixed. The safranin may be used several times.

The picro-anilin stain is prepared as follows: Make a saturated solution of picric acid and one of anilin blue, each in 95 per cent. alcohol. From these two make a single alcoholic solution containing 78 per cent. of the picric acid and 22 per cent. of the anilin blue solutions.

The staining process is as follows:

(1) Rinse sections with 50 per cent. alcohol.

(2) Flood sections with safranin and leave two hours.

(3) Wash off excess safranin with 50 per cent. alcohol leaving sections light pink in color. If the sections remain red, bleach with 70 per cent. alcohol to which a few drops of acetic acid have been added.

(4) Flood sections with picro-anilin blue and leave two hours.

(5) Draw off excess stain and wash sections for ten seconds in absolute alcohol.

(6) Transfer sections to clove oil and mount in Canada balsam.

The above method of differential staining is one of substitution, whereby the alcoholic solution of picro-anilin blue is made to wash out the safranin from all but so-called structures, for which the latter stain has a great affinity.

Criticism might be aimed at the short period of time for step five above in dehydrating, but results secured seem to justify the means used, a longer period causing excessive loss of color.

Using white oak wood as an example, the middle lamella is stained red, crystal forms a bright blue, and cell walls from light-yellow to blue or greenish-blue. Furthermore, in oak, many wood fibers whose lumen was constricted to a wavy line or "lazy S" in shape were found to have the entire thickened inner or tertiary wall stained a bright blue, while the secondary layer (in these fibers comparatively narrow) was stained yellow or olive green like the entire wall exclusive of the middle lamella of some other fibers.

An identification of these fibers with blue inner walls links them closely with mucilaginous cells. According to Jeffrey,[1] the presence of these cells reduces the swelling and shrinking of wood.

In addition to the differentiation obtained, this combination of stains has the advantage that the general yellow-green or apple-green hue of the sections is not tiring to the eye.

R. W. SMITH

U. S. FOREST PRODUCTS LABORATORY,
THE UNIVERSITY OF WISCONSIN

[1] Jeffrey, E. C. "The Anatomy of Woody Plants," p. 35.

SPECIAL ARTICLES

THE COINCIDENT PRODUCTION OF DEXTRAL AND SINISTRAL YOUNG IN THE LAND-GASTEROPOD PARTULA

AMONG the many problems of gasteropod asymmetry, none is more interesting than that which is concerned with the nature of the factors by which the direction of the coil is controlled. According to general experience, the prevailing mode is the dextral or clockwise from foot to apex when viewed from in front; the opposite sinistral form of coil is displayed by occasional examples of some dextral species. Again, certain species are uniformly sinistral, while others are sinistral in the main with sporadic dextral individuals. It is justifiable to denote the direction of the coil, a hereditary quality, on the same grounds that any other resemblances between offspring and parents are called hereditary, even though the parental characters are not always repeated faithfully in the progeny.

Boycott and Diver[1] have recently recorded the results of their studies upon Limnaea in which they have employed the usual dextral and the unusual sinistral kinds of snails. They regard their findings as evidence that dextrality is a Mendelian dominant with reference to the reversed mode of coil. Sturtevant[2] discusses the results of Boycott and Diver, and ingeniously interprets them in terms of maternal inheritance under earlier chromosomal control. Morgan[3] reviews the phenomena of spiral cleavage in relation to the dextral and sinistral modes of coil, and accepts Sturtevant's interpretation.

Mayor[4] and the present writer[5] have studied the Partulae living in Tahiti, where certain colonies of species, such as *Partula otaheitana,* comprise both dextral and sinistral snails. We found no exceptions to the rule that the young produced at any one time by a given adult were *all* of the *same* mode of coil, whether or not this agreed with the parental form of asymmetry. An adult of either type might bear young of its own mode exclusively or a series of offspring which all displayed the opposite direction of twist. Boycott and Diver observed the same relations in most of the offspring broods of Limnaea, but mixed broods also occurred in their material.

Exceptional instances have now been found in a species of Partula where dextral and sinistral young occurred simultaneously in the parental brood-pouch. The species in question is *Partula suturalis,* which dwells in the island of Moorea, a member of the Society Islands, situated about 20 miles from Tahiti. This species now ranges over almost all Moorea, and some of its colonies are made up of both dextral and sinistral snails. When the embryonic young were extracted from the parent animals taken in the valley of Faamaariri in the Vaiare region, five cases were found where two young were present in the brood-pouch, one of which was sinistral, while the other was dextral. In four of these instances the parent was dextral and in the fifth case the adult was sinistral.

It is particularly interesting that the exceptions herein recorded were found in *only one* association of mixed character. In this Faamaariri series, the noteworthy instances number five out of 148 where two or more young were present in the brood chamber; the

[1] Proc. Roy. Soc., 95 B, 1923.
[2] SCIENCE, LVIII, No. 1501, 1923.
[3] *Scientific Monthly,* XVIII, No. 3, 1924.
[4] Mem. Mus. Comp. Zool., XXVI, No. 2, 1902.
[5] Carnegie Inst. Pub. No. 228, 1917.

rest conformed to the general rule. If the data relating to all the mixed colonies of *Partula suturalis* are assembled, the summary is as follows: Cases where two or more young are *like* the parent, 1,133; cases where two or more young are *unlike* the parent, 184. There are, therefore, 1,317 instances in the *suturalis* material in which the rule is observed. If the facts are brought together for all the colonies of Tahitian and Moorean species in which dextral and sinistral snails occur, the number of conformable instances amounts to more than 3,000. In sharp contrast with all these, there are only five observed cases of mixed broods in Partula, and these have been found in only one species, in a single locality.

Sturtevant's proposed explanation of the hereditary mechanism in the cases where the rule is followed is both plausible and attractive. The exceptional occurrence of mixed broods in Limnaea and Partula would indicate that the hereditary procedure postulated by Sturtevant is not invariable, and that there are unusual circumstances under which additional factors may operate so as to produce other than the expected results.

HENRY E. CRAMPTON

BARNARD COLLEGE,
COLUMBIA UNIVERSITY

THE AMERICAN CHEMICAL SOCIETY

DIVISION OF INORGANIC AND PHYSICAL CHEMISTRY

(Continued from page 492)

The oriented wedge theory of emulsions: distribution of sizes in emulsions produced by oleate soaps: WILLIAM D. HARKINS and ERNEST B. KEITH. In an earlier paper (1917) it was indicated that the shape of the soap molecules in the interface between water and oil is an important factor in the determination of the sizes of the drops in emulsions and also of the type of emulsion as oil dispersed in water, or water dispersed in oil. Finkle, Draper and Hildebrand determined the distribution of sizes for benzol dispersed by sodium, potassium and caesium palmitate as 5.0, 3.7 and 2.5 microns, respectively, at the peaks which represent the greatest number of drops of a certain size. We find: (1) The size of the drops of the emulsions is highly dependent upon the nature of the oil which is dispersed. Thus the peak for the greatest number of drops for sodium oleate as an emulsifying agent comes at 1.94 microns in benzol and mesitylene, 3.9 microns in octane and 9.2 microns in stanolax. (2) The peaks lie on an equilateral hyperbola. In octane the sizes for lithium, sodium, potassium and caesium oleates are: 4.7, 3.9, 2.9 and 1.95 microns at the respective peaks. In stanolax the sizes for sodium, potassium and caesium oleates are: 9.2, 6.9 and 4.6 microns. (3) Bases, salts and oleic acid produce marked changes in the size. Their effect is to greatly reduce the size of the drops. (4) The oil drops are negatively charged. The potential difference between the oil drops and the water is 60 millivolts for a sodium oleate and nearly the same for a caesium oleate emulsion of octane. The addition of sodium hydroxide greatly reduces this P. D. Various other relations of emulsions will be presented.

Interfacial tension in systems of importance in connection with emulsification: WILLIAM D. HARKINS and W. A. THOMAS. Bancroft and Clowes have shown that salts produce marked effects upon the interfacial tension between water and oil when a soap is adsorbed at the interface. Clowes' results are expressed as the number of drops formed from a certain pipette, and can not be transformed into surface energy values. The writers have carried out measurements by the use of water 0.001 molar with respect to sodium hydroxide, which was dropped into purified stanolax which was 0.001 molar with respect to oleic acid. The interfacial tension was found to be 7.2 dynes per cm at 20°, while when pure water is dropped into pure oil the value is 31.05. When the solution of the base is made 0.15 molar with respect to sodium chloride the interfacial tension is reduced to 0.00 dynes per cm, or a value too small to be measured with the apparatus then available. With olive oil the corresponding value was 0.023. With 0.001 M. sodium hydroxide and 0.0015 M. calcium chloride the surface tension is increased to 9.65, while when both sodium and calcium chlorides are present with respective concentrations 0.15 M. and 0.0015 M. the value is 7.48. This value keeps nearly constant if the two salts are increased in concentration, but with the ratio of the concentrations kept at 100 to 1. As has been pointed out, sea urchins will live in salt solutions in which the ratio of sodium to calcium chloride is 80 to 1, but not in water in which only one of these salts is present.

Plasticity and melting points: EUGENE C. BINGHAM, L. T. BROWNMILLER and NORMAN WIGGINS. The melting point of a substance often depends upon the flow of the material. There are three softening temperatures to be distinguished and the solidifying point is often quite different from the melting point. The measurement of the plasticity of materials through the softening range makes possible more precise measurements of the transition temperatures than heretofore.

Plasticity and solubility: EUGENE C. BINGHAM and J. K. ROSS. When a colloid is described as being more soluble in one solvent than in some other, the difference depends upon the flow of the materials. It is suggested that the yield value may be a measure of insolubility. As the temperature is raised the solubility becomes infinite. Is the solution a "true solution"?

Suspensions vs. emulsion colloids: EUGENE C. BINGHAM and C. RAYMOND HOOD. Polar and non-polar colloids are quite sharply distinguished by means of the plastometer. The yield value in suspensions has been found to be independent of the dimensions of the plastometer but this is not true of polar colloids. This latter peculiarity has not before been noted.

Viscous liquids for viscometer calibration: EUGENE C. BINGHAM and H. R. ARNOLD. There is need for pure substances which do not absorb water or otherwise change in fluidity, whose fluidity is about that of lin-

seed oil. The authors have studied several substances of this type. Butyl tartrate is an example whose fluidity is 0.344 at 5° and 1.16 at 20° C.

The effect of hydrophilic colloids on size and distribution of particles in electrolytic precipitation. II. Gelatin and basic lead carbonate: influence of temperature: DORMAN MCBURNEY and WESLEY G. FRANCE. In an earlier paper it was shown that the presence of gelatin over a concentration range of 0 per cent. to 1 per cent. decreases the average size, and increases the uniformity of the particles of basic lead carbonate, electrolytically precipitated at 20° C. In the present work the effect of gelatin on the particle size and uniformity of the precipitate has been investigated over a temperature range of 5.0° to 50.0° C., and a similar effect, but of different magnitude, observed for each temperature. However, the maximum sized particles were found at 20°, while above or below this temperature, the average particle sizes were smaller and the uniformity greater.

Platinized alundum cathodes in electro-analysis: T. S. ECKERT and WESLEY G. FRANCE. The suitability of platinized alundum as a substitute for platinum gauze in electro-analysis has been studied. The conclusion reached after an investigation of the factors involved in the electro-deposition of copper is that cathodes of platinized alundum are unsatisfactory for the following reasons: (1) The weight of the cathodes was not constant; (2) the circulation of the electrolyte was too slow; (3) due to adsorption extreme precautions in washing, drying and weighing were required; (4) the metal deposit oxidized rapidly.

A new apparatus for the measurement of transference numbers by moving boundaries: THOS. B. BRIGHTON. This apparatus is devised to simplify measurements by the moving boundary method. The boundaries between solutions are made by a device which slides the indicator solutions on to the solution to be studied. Boundaries are sharp and measurements are easily made.

Transfer resistance: ALFRED L. FERGUSON and GERRIT VAN ZYL. A set-up is described by means of which measurements may be made by both the direct and the commutator methods at the same time and under identically the same conditions. The commutator is so constructed that the potentials may be measured over the whole period during which the electrodes are being charged or discharged, or over any portion of this period. The belief is expressed that the results indicate there is no such thing as "transfer resistance," and that the conception developed, due to the use of potential values which did not represent the things they were assumed to represent.

The electrometric determination of Ph in the presence of copper salts: VICTOR K. LAMER and PAUL M. HORTON. The presence of minute traces of copper salts is sufficient to interfere seriously with the use of the hydrogen electrode, owing to a poisoning of the electrode by the reduction of cupric ions to metallic copper. The potentials of the benzoquinhydrone electrode system are positive to those of the cupric—cuprous and cupric—metallic copper systems so that reduction of these ions does not occur when this electrode is used in acid solution. Using this electrode it has been possible to obtain potentials, which are comparable with the hydrogen electrode as regards stability and reproducibility over periods of time up to six hours in the presence of saturated copper sulfate. The method has enabled us to study the effect of Ph on the adsorption of cupric ions by charcoals of different preparations. The simplicity, accuracy and speed with which Ph determinations can be made with the quinhydrone electrode recommend its use in other cases where poisoning of the hydrogen electrode is due to the presence of copper or other ions whose electrode potentials are less than 0.6990 volts positive to the hydrogen electrode, and the method should be of value in the control of the acidity of commercial nickel and cobalt plating baths where traces of copper ions are almost invariably present, as well as detecting the presence of free acid in copper sulfate solutions.

Diphenylamine as indicator in the reduction of vanadic acid: N. HOWELL FURMAN. Knop has proposed the use of diphenylamine as indicator in the ferrous iron—bichromate reaction. In this investigation it was found that diphenylamine gave a sharp change—deep blue to residual color of solution—at the completion of the reaction: $VO^{-}_{4} + Fe^{+++} + 6H^{+} \rightarrow VO^{++} + Fe^{+++} + 3H_2O$. The intense blue vanadium color reaction has been previously reported. Diphenylamine reduces vanadic acid. A slight correction, empirically determined, must therefore be added to the volume of ferrous sulfate. The correction was 0.07 cc of 0.02 N $FeSO_4$ per 0.2 cc indicator (0.1 g diphenylamine in 100 cc concentrated H_2SO_4). A sufficient quantity of phosphoric acid must be present to mask the color of the ferric iron. Accurate vanadium results were obtained when Fe^{III}, As^{V}, and U^{VI} were present. Bichromate ion or other substances which oxidize iron readily must be absent or determined separately. The method was successfully applied to the determination of chromium and vanadium in analyzed steels (Bureau of Standards Nos. 30b and 50).

A new absorbent for oxygen in gas analysis: LOUIS F. FIESER. An alkaline solution of sodium hydrosulfite containing a small amount (2 per cent.) of anthraquinone-β-sulfonic acid as catalyst completely absorbs the oxygen from a 20.9 per cent. sample on shaking for one minute and from a 90 per cent. sample in two minutes. The reagent, characterized by its low viscosity, is less expensive and more easily handled than pyrogallol, can not evolve carbon monoxide and indicates the point of exhaustion by a color change, maximum speed of absorption being maintained up to this point.

The use of bromate in volumetric analysis. IV. The preparation and properties of normal and basic mercuric bromate: G. FREDERICK SMITH. The preparation of normal and basic mercuric bromates by the interaction of mercuric perchlorate and sodium bromate in acid and in practically neutral solutions is described. The relation of the hydroxy-mercuric bromate to known mercuric salts with complex cations is pointed out. The solubilities of the two bromates in various concen-

trations of nitric and perchloric acids at 25° are determined. The hydrolysis of normal mercuric bromate with the formation of basic mercuric bromate and free bromic acid in considerable concentration is demonstrated. Basic mercuric bromate is shown to be preferable as a reagent for volumetric bromate reactions.

The analytical separation of rhodium from platinum: EDWARD WICHERS. No adequate method for this separation has hitherto been proposed. The usual procedure of separation by ammonium chloride fails because the precipitation of platinum is incomplete and because the precipitate is always contaminated with rhodium. Rhodium may be separated quantitatively from platinum by hydrolysis in faintly alkaline chloride solutions. Two precipitations are sufficient for ordinary analytical work, and three insure great accuracy. Hydrolysis is effected by adding freshly precipitated barium carbonate and boiling for two to three minutes. Soluble alkalies react with platinum chloride rapidly enough to yield a slightly acid solution on boiling, which prevents the complete precipitation of rhodium. Results are given for mixtures of platinum with 0.1 per cent. to 10 per cent. of rhodium.

The analytical separation of copper from the platinum metals: WM. H. SWANGER and EDWARD WICHERS. In the various methods for the analysis of crude platinum or of platinum alloys, the separation of copper is usually made by leaching with nitric acid the ignited mixture of sulfides of copper and whatever platinum metals were precipitated with it. Data are given to show that nitric acid will not dissolve all the copper from such a mixture, especially if rhodium is present. The familiar precipitation of copper as cuprous thiocyanate will separate it quantitatively from platinum, palladium, iridium and rhodium, if certain conditions, set forth in the paper, are maintained.

The precise determination of the boiling points of oxygen and carbon dioxide, with application to the calibration of platinum resistance thermometers: A. G. LOOMIS and J. E. WALTERS. A careful study has been made of the best conditions to determine the normal boiling point of pure oxygen and the normal sublimation point of carbon dioxide. Especial attention was given to the elimination of errors arising from thermal lag, improper stirring and unsuitable baths. Curves for various conditions are given, together with the probable error for each set of determinations. The precise determination of these points under the best conditions is applied to the calibration of platinum resistance thermometers and a careful check of the Henning method of calibration at low temperatures is given.

A simple cryostat for precise regulation of temperature to —150° C: J. E. WALTERS and A. G. LOOMIS. A cryostat has been developed which employs automatic cooling by means of liquid air. An automatically controlled heater is used to supplement the cooling for finer regulation. The heater may be operated by hand if desired. Rapid stirring of the bath in a large Dewar tube is accompanied by a turbine-type stirrer which contains the cooling and heating elements. By this means lag effects and lateral currents from the stirrer are eliminated. Desired temperatures have been held for considerable periods, with a total variation of not more than 0.01° C.

The accurate quantitative determination of minute amounts of mercury: HAROLD S. BOOTH and NORA E. SCHREIBER. The defects of the various methods at present in use to determine minute amounts of mercury in body fluids are pointed out; chief among these are the errors due to the volatility of mercury salts and to the hydrolysis of dilute water solutions of mercury salts. It is shown that in extremely dilute solutions of mercury salts hydrolysis causes the formation of colloidal mercury compounds. Therefore, any quantitative method which does not provide for the determination of both the colloidal mercury compounds and the ionic mercury will fail to provide an accurate determination of mercury. The authors oxidized the organic compounds present in the body fluids by digestion with potassium permanganate and sulfuric acid. The excess permanganate is reduced by hydrogen peroxide and the latter removed by boiling. Hydrogen sulfide is then bubbled into the clear solution forming mercuric sulfide and the excess hydrogen sulfide is removed by bubbling pure air through the solution. The solution is made almost alkaline by adding 25 per cent. sodium hydroxide solution, and is then well stirred; and then 5 cc of a 1 per cent. sodium hydroxide solution is so added as to float on top. This forms flocculent manganous hydroxide, which acts as a coagulum and enmeshes in it as it settles both the mercuric sulfide and the colloidal mercury compounds. A test of the filtrate showed that less than one part of mercury per billion was left in the solution, which is as near complete precipitation as could be desired. The precipitate is filtered and dried, and then ground up with magnesium oxide and placed in a long ten millimeter tube and sealed at both ends. The tube is heated for three hours at 500° to decompose the mercury which distils over and condenses in the empty cold end. When decomposition is complete the tube is carefully opened and the mercury is collected into one globule with the aid of a glass rod drawn out to a hair, and transferred to a special measuring device which will be described. Tests show that the method is extremely accurate.

Detection of minute traces of mercury. A microelectro method sensitive to five parts of mercury per billion parts of solution: HAROLD S. BOOTH and NORA E. SCHREIBER. A review of the literature failed to reveal any real study of the sensitivity of the qualitative tests for mercury. A thorough study of the known qualitative tests of mercury and numerous others which occurred to us showed that none had a sensitivity greater than five parts per million and most of them were much less sensitive. Some of these tests had been used to control quantitative methods and were found to be less sensitive than the quantitative accuracy that the investigators were striving for required. The new method we have developed consists briefly of electrolytically depositing the mercury from a drop of the solution to be tested upon a microscopically fine point cathode of

copper wire which is then examined under the microscope. About 25 cc of the solution to be tested is evaporated isothermally, the residue moistened with a drop of nitric acid, transferred to a hollowed microscope slide and electrolytically deposited on the microscopic copper point. This deposit under the microscope is a silvery white amalgam turning greenish yellow upon standing. The limit of sensitivity of the method is about five parts per billion. The method is applicable to other metals low in the electromotive series and a study of them is now under way.

A new accurate gas burette—the baro-burette: HAROLD S. BOOTH. The chief source of error in attempting to measure gases accurately in an ordinary gas burette is due to the necessity of indirect measurement of the pressure: that is, the operator attempts to obtain the same pressure on the gas in the burette as the pressure of the atmosphere and the latter pressure is then measured separately. In the author's baro-burette the gas burette becomes the well of a barometer and thus the pressure of the gas is measured directly. A vertical glass tube set parallel to the gas burette is connected to the bottom of the gas burette, while just above the stopcock of the burette this parallel tube is offset and expands into a larger tube of the same diameter as the burette. This upper tube is in the same axis as the burette and is the upper limb of the barometer. This upper limb terminates at the top in a capillary tube which is bent over and down so as to lie parallel to the upper limb of the barometer for about 80 cm; the bottom of the capillary tube which is bent up and expanded into a larger tube which in turn is terminated by a stopcock leading to a vacuum pump. A leveling bulb for the mercury is connected by pressure tubing to the bottom of the burette as usual. The method of manipulation of the apparatus will be described with the aid of lantern slides.

The quantitative determination of reduction products of free nitric acid solutions, namely: nitrogen peroxide, nitric oxide, nitrous oxide, nitrogen, nitrous acid, and salts of hydroxylamine, hydrazine and ammonia: LOWELL H. MILLIGAN. The development of these analytical methods is part of an investigation now being made at Cornell University, on the action of nitric acid on metals, or more generally, the mechanism of the reduction of nitric acid. Some of the procedures are applications of old methods, others are new. Space does not permit a detailed description of the methods, which will be published soon.

The reduction of free nitric acid by means of ferrous, stannous or titanous salts: LOWELL H. MILLIGAN and G. RAYMOND GILLETTE. When an excess of dilute HNO_3 is reduced. (1) by Fe^{++} solutions the end products are NO and a smaller amount of NO_2; (2) by Sn^{++} solutions, the primary end-produce is NH_2OH salt, but under many conditions this reacts with the excess HNO_3 forming N_2O together with small amounts of NO, N_2, and traces of NO_2, but no NH_4^+; (3) by Ti^{+++} solutions, the reaction takes place very rapidly forming NO as the chief product together with a considerable amount of N_2O, a smaller amount of N_2 and traces of NO_2 and NH_2OH salt. When the reducing agent is in excess, (1) produces NO; (2) NH_2OH and NH_4^+ salts, and (3) gives practically the same products as when the HNO_3 is in excess. Ti^{+++} salts are stronger reducing agents than corresponding Sn^{++} salts, yet the latter produces a "more reduced" product showing that catalytic effects come in which seem to be due to the "ous" salt of Ti. In order to explain the results the main reactions are assumed to take place through the stages, $HNO_3 \rightarrow N_2N_2O_5 \rightarrow HNO_2 \rightarrow H_2N_2O_4 \rightarrow H_2N_2O_2 \rightarrow NH_2OH \rightarrow NH_3$. Dehydration of $H_2N_2O_4$ produces NO_2; of $H_2N_2O_3$ produces NO; of $H_2N_2O_2$ produces N_2O. N_2 is produced by interaction of NH_2OH with some preceding stage or stages. The formation of NH_3 may not necessarily take place through NH_2OH.

A convenient potentiometer set-up: ALAN LEIGHTON. The paper deals with a system of wiring whereby a Leeds and Northrup, type K, potentiometer is connected through suitably balanced resistances onto the main 220 volt circuit of the laboratory. The usual storage battery which ordinarily supplies power for the potentiometer is then connected across the terminals of the potentiometer. Sufficient current is permitted to pass from the 220 volt circuit not only to maintain the necessary potentiometer voltage, but also to keep a small charging current going into the battery. Since the internal resistance of the battery is insignificant as compared with the resistance of the potentiometer the normal variations of the main power line will be absorbed by the battery, and the voltage at the terminals of the potentiometer will remain constant, to all intents and purposes. The arrangement does away with the inconvenience of charging the storage battery frequently, and overcomes the difficulties encountered when a freshly charged battery is connected into the potentiometer circuit. Sufficient current is passed into the battery to keep it charged at all times, thus insuring that the potentiometer is in working order continuously.

Pure fused uranium: J. W. MARDEN and H. C. RENTSCHLER. Uranium was prepared by reduction of potassium uranium fluoride with pure magnesium in a high vacuum, high frequency induction furnace. By this new process the metal can be prepared in a pure fused condition without the intermediate steps of washing and handling. Other products of the reaction are distilled away from the metal. Samples are ductile.

The use of perchloric acid in the determination of the cyanogen contents of waste gas liquors: J. P. SIMONS. The modified Knublench method and Williams' distillation method for the determination of ferrocyanide give unsatisfactory results. Inaccuracy in the former method is due largely to difficulty in obtaining satisfactory end points. With Williams' method results averaged seven tenths of a per cent. low. The successful use of perchloric acid in the determination of silica in silicates and as a substitute in kjeldahl digestions suggested its use in Williams' method instead of sulfuric acid. A number of analyses of highly purified potassium ferrocyanide and of several samples of gas residues gave results which were entirely satisfactory.

GRAHAM EDGAR,
Chairman